

What is claimed is:

1. A liquid injection system comprising:

a liquid syringe having a cylinder with a cylinder flange disposed on and around an end thereof and a piston slidably inserted in said cylinder and having a piston flange disposed on and around an end thereof; and

5 a liquid injector for holding and moving at least said cylinder flange and said piston flange relatively to each other;

said liquid injector comprising a cylinder gripping mechanism for gripping said cylinder such that said cylinder has a longitudinal direction oriented forwardly and rearwardly, a piston pusher supported slidably in forward and rearward directions for pushing said piston at least forwardly, a pair of en-
10 gaging claws laterally openably and closably mounted on said piston pusher for individually engaging left and right edges of a front face of said piston flange, and gripping detecting means for detecting when said piston flange is gripped by said engaging claws.

15 2. A liquid injection system according to claim 1, wherein said gripping detecting means comprises means for detecting when a rear face of said piston is pushed against a front face of said piston pusher.

3. A liquid injection system according to claim 2, wherein said gripping detecting means comprises:

a displacement detecting member for being pressed by said rear face of said piston;

5 a member support means for supporting said displacement de-
tecting member such that said displacement detecting member can be dis-
placed forwardly and rearwardly;

 member biasing means for normally urging said displacement
detecting member forwardly; and

10 retraction detecting means for detecting when said displacement
detecting member is retracted to a predetermined position.

4. A liquid injection system according to claim 3, wherein said
piston has a concave defined centrally in the rear face thereof, at least said
displacement detecting member of said gripping detecting means being en-
gageable in said concave.

5

5. A liquid injection system according to claim 3, wherein said
piston has a convex disposed centrally on the rear face thereof, and said piston
pusher has a concave defined centrally in the front surface thereof, said convex
being engageable in said concave, said gripping detecting means being dis-
posed in said concave.

5

6. A liquid injection system according to claim 2, wherein said
gripping detecting means comprises:

 wave range finder device for measuring a distance up to the rear
face of said piston with a wave, and gripping determining means for detecting
when a distance measured by said wave range finder falls in a predetermined
range.

5

7. A liquid injection system according to claim 6, wherein said wave range finder device comprises an ultrasonic range finder for ultrasonically measuring the distance up to the rear face of said piston.

8. A liquid injection system according to claim 6, wherein said wave range finder device comprises an optical range finder for optically measuring the distance up to the rear face of said piston.

9. A liquid injection system according to claim 2, wherein said rear face of said piston comprises a reflecting surface, and said gripping detecting means comprises a light-emitting element for emitting a light beam at a predetermined angle to said reflecting surface, and a light-detecting means
5 for detecting a light beam reflected by said reflecting surface at a predetermined position.

10. A liquid injection system according to claim 2, wherein said rear face of said piston has an arm disposed thereon, and said gripping detecting means comprises a light-emitting element for emitting a light beam along a path interruptable by said arm, and a light-detecting means for detecting a light
5 beam emitted from said light-emitting element along a path which is not interrupted by said arm.

11. A liquid injection system according to claim 2, wherein said rear face of said piston has a magnet mounted thereon, and said gripping detecting means comprises a Hall device for detecting said magnet.

12. A liquid injection system according to claim 2, wherein said rear face of said piston has an arm disposed thereon, and said gripping detecting means comprises a pair of electrode terminals resiliently biased to be short-circuited to each other and separable away from each other by said arm when
5 the arm is forced in between said electrode terminals.

13. A liquid injection system according to claim 2, wherein said rear face of said piston has an electrically conductive member mounted thereon, said gripping detecting means comprises a pair of electrode terminals spaced from each other for being short-circuited to each other by said electrically conductive member.
5

14. A liquid injection system according to claim 2, wherein said gripping detecting means comprises:
a load cell for detecting a pressure under which the rear face of said piston is pushed against the front face of said piston pusher; and
5 gripping determining means for detecting when said piston flange is gripped by said engaging claws based on a change in the pressure detected by said load cell.

15. A liquid injection system according to claim 1, wherein said gripping detecting means comprises means for detecting when said engaging claws are opened from an initial closed position into opposite sides and then closed.
5

16. A liquid injection system according to claim 15, wherein said gripping detecting means comprises means positioned on an outer surface of said piston pusher for detecting when said piston flange is pressed by an inner surface of each of said engaging claws.

5

17. A liquid injection system according to claim 15, wherein said gripping detecting means comprises means positioned outside of said piston pusher for detecting when said piston flange is pushed by each of said engaging claws which are opened.

5

18. A liquid injection system according to claim 17, wherein said gripping detecting means comprises a number of sheet-like touch switches mounted in succession on a tape.

19. A liquid injection system according to claim 15, wherein said gripping detecting means comprises:

a pair of light-emitting elements for emitting respective light beams along paths interruptable by said engaging claws which are opened;

5

and

a pair of light-detecting elements for detecting light beams emitted respectively from said light-emitting elements along paths which are not interrupted by said engaging claws.

20. A liquid injection system according to claim 1, wherein said piston has a rear face and said piston pusher has a front face, said rear face

and said front face having a concave and a convex which are engageable with each other.

5

21. A liquid injection system according to claim 1, further comprising a guide projecting forwardly from said piston pusher at a position different from said engaging claws, for engaging an outer circumferential surface of said piston flange.

5

22. A liquid injector for injecting a liquid from a liquid syringe having a cylinder with a cylinder flange disposed on and around an end thereof and a piston slidably inserted in said cylinder and having a piston flange disposed on and around an end thereof, said liquid injector being arranged to hold and move at least said cylinder flange and said piston flange relatively to each other, said liquid injector comprising:

5

a cylinder gripping mechanism for gripping said cylinder such that said cylinder has a longitudinal direction oriented forwardly and rearwardly;

a piston pusher supported slidably in forward and rearward directions for pushing said piston at least forwardly;

10

a pair of engaging claws laterally openably and closably mounted on said piston pusher for individually engaging left and right edges of a front face of said piston flange; and

gripping detecting means for detecting when said piston flange is gripped by said engaging claws.

15

23. A liquid injector according to claim 22, wherein said gripping detecting means comprises means for detecting when a rear face of said piston is pushed against a front face of said piston pusher.

24. A liquid injector according to claim 22, wherein said gripping detecting means comprises means for detecting when said engaging claws are opened from an initial closed position into opposite sides and then closed.

25. A liquid syringe in a liquid injection system according to claim 4, wherein said piston has a concave defined centrally in the rear face thereof.

26. A liquid syringe in a liquid injection system according to claim 5, wherein said piston has a convex disposed centrally on the rear face thereof.

27. A liquid syringe in a liquid injection system according to claim 10, wherein said piston has a convex disposed centrally on the rear face thereof.

28. A liquid syringe in a liquid injection system according to claim 12, wherein said piston has a convex disposed centrally on the rear face thereof.

29. A liquid syringe in a liquid injection system according to claim 20, wherein said piston has a rear face, said rear face having a concave and a convex.

30. A liquid syringe in a liquid injection system according to claim 9, wherein said rear face of said piston comprises a reflecting surface.

31. A liquid syringe in a liquid injection system according to claim 11, wherein said rear face of said piston has a magnet mounted thereon.

32. A liquid syringe in a liquid injection system according to claim 13, wherein said rear face of said piston has an electrically conductive member mounted thereon.